UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	35.G2566
First Named Inventor or Application Identifier	
HIROYUKI URUSHIYA	
Express Mail Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

1. [X] Fee Transmittal Form
(Submit an original, and a duplicate for fee processing)

2. [X] Specification — *Total Pages* 25

3. [X] Drawing(s) *(35 USC 113)* — *Total Sheets* 11

4. [X] Oath or Declaration — *Total Pages* 1

   a. [ ] Newly executed (original or copy)
   b. [X] Unexecuted for information purposes
   c. [ ] Copy from a prior application (37 CFR 1.63(d))
   (for continuation/divisional with Box 17 completed)
   [Note Box 5 below]
   i. [ ] DELETION OF INVENTOR(S)
   Signed Statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).

5. [ ] Incorporation By Reference *(useable if Box 4c is checked)*
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4c, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

6. [ ] Microfiche Computer Program *(Appendix)*

7. Nucleotide and/or Amino Acid Sequence Submission
(if applicable, all necessary)
   a. [ ] Computer Readable Copy
   b. [ ] Paper Copy (identical to computer copy)
   c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. [ ] Assignment Papers (cover sheet & document(s))

9. [ ] 37 CFR 3.73(b) Statement *(when there is an assignee)* [ ] Power of Attorney

10. [ ] English Translation Document *(if applicable)*

11. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations

12. [ ] Preliminary Amendment

13. [X] Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)

14. [ ] Small Entity Statement(s) [ ] Statement filed in prior application Status still proper and desired

15. [ ] Certified Copy of Priority Document(s)
(if foreign priority is claimed)

16. [ ] Other: _____

17. If a CONTINUING APPLICATION, *check appropriate box and supply the requisite information:*
[ ] Continuation [ ] Divisional [ ] Continuation-in-part (CIP) of prior application No. ___/_____

18. CORRESPONDENCE ADDRESS

[X] Customer Number or Bar Code Label — 05514 (Insert Customer No. or Attach bar code label here) — or [ ] Correspondence address below

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+

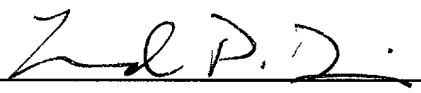
CLAIMS	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
	TOTAL CLAIMS (37 CFR 1 16(c))	29-20 =	9	X $ 18.00 =	$162.00
	INDEPENDENT CLAIMS (37 CFR 1.16(b))	7-3 =	4	X $ 78.00 =	$312.00
	MULTIPLE DEPENDENT CLAIMS (if applicable) (37 CFR 1.16(d))			$260.00 =	$0
				BASIC FEE (37 CFR 1.16(a))	$690.00
			Total of above Calculations =		$1164.00
	Reduction by 50% for filing by small entity (Note 37 CFR 1.9, 1.27, 1.28).				0
				TOTAL =	$1164.00

19. Small entity status
    - a. ☐ A Small entity statement is enclosed
    - b. ☐ A small entity statement was filed in the prior nonprovisional application and such status is still proper and desired.
    - c. ☐ Is no longer claimed.

20. ☒ A check in the amount of $ 1164.00 to cover the filing fee is enclosed.

21. ☐ A check in the amount of $ _____ to cover the recordal fee is enclosed.

22. The Commissioner is hereby authorized to credit overpayments or charge the following fees to Deposit Account No. 06-1205:
    - a. ☒ Fees required under 37 CFR 1.16.
    - b. ☒ Fees required under 37 CFR 1.17.
    - c. ☐ Fees required under 37 CFR 1.18.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED	
NAME	L. P. Diana (Reg. 29,296)
SIGNATURE	
DATE	April 5, 2000

NY_MAIN 73556 v 1

TITLE OF THE INVENTION

IMAGE PROCESSING APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an image processing apparatus for determining, extracting and correcting defective pixel signals from defective pixels in an array of pixels in a sensor.

Description of the Related Art

Hitherto, the following method has been employed for detecting and correcting defective pixel signals from defective pixels within a sensor array. A detected defective pixel signal pattern is stored as a binary image, as shown in Fig. 1. In correcting an image taken of a subject, the stored defective pixel signal pattern is read, and the individual pixel signals are sequentially searched. If there is any defective pixel signal, it is corrected by, for example, replacing it with an average value of the surrounding pixel signals.

If a defective pixel signal pattern is not formed, coordinate values of the individual defective pixels are stored, and corrections are performed on pixel signals

having the corresponding coordinates of a subject image in a manner similar to the above method.

However, the ratio of defective pixels to normal pixels within a sensor is very small, and in searching a defective pixel pattern, most of the pixels are merely skipped. Thus, searching the whole image takes time and is wasteful.

According to the technique using coordinate values of defective pixels in the sensor, a given defective pixel signal cannot be accurately corrected if there is another defective pixel near the given defective pixel in the sensor.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to achieve fast and precise correction of defective pixel signals from defective pixels in a sensor array.

In order to achieve the above object, according to one aspect of the present invention, there is provided an image processing apparatus including an extraction unit for extracting a defective pixel signal from a defective pixel included in an image-pickup device having a plurality of pixels and determining a defective pixel, and a block-forming unit for forming positional information of a plurality of the defective pixels determined by the extraction unit into a block.

According to another aspect of the present invention, there is provided an image processing apparatus including a storage unit for storing, in units of blocks, positional information of a plurality of defective pixels included in an image pickup device having a plurality of pixels, and a correction unit for correcting defective pixel signals of the defective pixels in the image pickup device in units of blocks by using the positional information of the defective pixel signals stored in the storage unit.

According to still another aspect of the present invention, there is provided an image processing method including: a first step of extracting a defective pixel signal of a defective pixel included in an image pickup device having a plurality of pixels; and a second step of forming positional information of a plurality of defective pixels in the image pickup device into a block based on the extracted defective pixel signals.

According to a further aspect of the present invention, there is provided an image processing method including: a first step of reading, in units of blocks, positional information of a plurality of defective pixels included in an image pickup device having a plurality of pixels; and a second step of correcting defective pixel signals of the defective pixels in the image pickup device in units of blocks.

According to a yet further aspect of the present invention, there is provided a storage medium for storing a program which includes: a first step of extracting a defective pixel signal of a defective pixel included in an image pickup device having a plurality of pixels; and a second step of forming positional information of a plurality of defective pixels in the image pickup device into a block based on the extracted defective pixel signals.

According to a further aspect of the present invention, there is provided a storage medium for storing a program which includes: a first step of reading, in units of blocks, positional information of a plurality of defective pixels included in an image pickup device having a plurality of pixels; and a second step of correcting defective pixel signals of the defective pixels in the image pickup device in units of blocks.

According to a further aspect of the present invention, there is provided an image processing system including an image pickup device for picking up an image of a subject, an image processing apparatus performing image processing of a signal from the image pickup device, including: a storage unit for storing, in units of blocks, positional information of a plurality of defective pixels included in the image pickup device having a plurality of pixels; and a correction unit for correcting defective pixel signals of the defective

pixels in the image pickup device in units of blocks by using the positional information of the defective pixel signals stored in the storage unit, a monitor for monitoring image data processed by the image processing apparatus, a network for transmitting the image data processed by the image processing apparatus, and an image database, connected to the network, storing the image data.

Further objects, features and advantages of the present invention will become apparent from the following description of the preferred embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 schematically illustrates a conventional method of detecting and correcting defective pixel signals of defective pixels in an image pickup unit;

Fig. 2 is a block diagram illustrating an image processing apparatus according to an embodiment of the present invention;

Figs. 3 and 4 are flow charts illustrating processing executed by the image processing apparatus shown in Fig. 2;

Fig. 5 illustrates a method of detecting with high precision defective pixel signals of defective pixels in an image pickup unit;

Fig. 6 illustrates extraction of defective pixel signals of defective pixels in an image pickup unit;

Fig. 7 illustrates run-length coding of position information;

Fig. 8 illustrates extraction of defective pixel signals and embedding of corrected defective pixel signals in place of corresponding defective pixel signals in an image signal;

Fig. 9 illustrates correction of defective pixel signals;

Fig. 10 illustrates correction of defective pixel signals taking the arrangement of a filter into consideration; and

Fig. 11 illustrates the entire configuration of a digital X-ray system using an image processing apparatus according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 2 illustrates the system configuration of an image processing apparatus according to an embodiment of the present invention. Figs. 3 and 4 are flow charts illustrating processing executed by the image processing apparatus shown in Fig. 2.

The image processing apparatus shown in Fig. 2 includes

the following elements. An image input unit 5, which serves as an image pickup device, receives a pixel signal from a sensor having an array of a plurality of pixels, such as from an X-ray sensor. A data storage unit 6 stores information of, for example, defective pixels. An image processing unit 7 performs image processing on the defective pixel signal input into the image input unit 5 by using the information stored in the data storage unit 6. A system control unit 8 controls the image input unit 5, the data storage unit 6, and the image processing unit 7.

Extracting defective pixel signals and storing positional information of defective pixels is discussed below with reference to Figs. 2 and 3.

In Fig. 3, in step S1, the image input unit 5 receives a pixel signal of a white image, which has been taken without a subject, from the sensor. In step S2, the system control unit 8 causes the image input unit 5 to transmit the input pixel signal to the image processing unit 7 and instructs the image processing unit 7 to extract defective pixel signals. The image processing unit 7 then extracts all the defective pixel signals. In step S3, in response to an instruction from the system control unit 8, the image processing unit 7 combines a plurality of items of coordinate data, which indicate positional information of the defective pixels extracted by the operation in step S2,

into a block. Then, in step S4, the system control unit 8 stores the blocks of coordinate data in the data storage unit 6.

The operations in steps S2 and S3 are discussed below in detail.

Concerning the extraction of defective pixel signals in step S2, a certain threshold may be set, and pixel signals having a value smaller than the threshold may be determined to be defective pixel signals from corresponding defective pixels in the sensor.

According to a technique of detecting defective pixel signals with higher precision, a white image is divided into blocks, as shown in Fig. 5, and an average signal value and a standard deviation from the average signal value within each block are determined. Then, pixel signals having a signal value which is outside a range of (the average signal value ± (n × standard deviation)), where n is a specified signal value, are determined to be defective pixel signals.

Correction of defective pixel signals in step S3 is as follows. The plurality of items of coordinate data of the defective pixel signals detected in step S2 are formed into one block, as shown in Fig. 6. As an example of techniques of forming the coordinate data into a block of positional information (local defective-pixel information), a run-length coding technique shown in Fig. 7 may be employed.

In run-length coding, defective pixels which are continuously located in an X direction (horizontal direction) or a Y direction (vertical direction) are integrated into a group, and the first coordinate value and the length (and the direction if necessary) of the group are coded.

A technique of forming the plurality of items of defective pixels into groups by using the above-described run-length coding is as follows. For simple representation, run-length coding is performed only in the X direction.

For example, as shown in Fig. 7, since a pixel having coordinates (n,m) and a pixel having coordinates (n+1,m) are adjacent to each other with a length 2 in the X direction, they are coded into information (n,m) L2. Similarly, a pixel (n+1,m+1) and a pixel (n+2,m+1) are coded into (n+1,m+1) L2, and pixels (n,m+2), (n+1,m+2), (n+2,m+2), (n+3,m+2) are coded into (n,m+2) L4. Then, as another run-length code positioned adjacent to a given run-length code, pixels having ±1 Y coordinate are extracted. Among these pixels, pixels which are continuously placed in the X direction are grouped into a run-length code. In Fig. 7, if a given run-length code is determined to be (n,m) L2, pixels having ±1 Y coordinate and continuously located from X coordinate (n+1) are selected as a run-length code (n+1,m+1) L2 adjacent to the given run-length code (n,m) L2. The

above-described operation is performed to obtain all the run-length codes, thereby integrating all the defective pixels into groups of local defective-pixel information.

The coordinate data of the defective pixels may be formed into blocks by a technique other than the above-described run-length coding. For example, by using normal x- and y-coordinate positional data, eight pixels in proximity with each other in the sensor may be checked for any adjacent defective pixels by checking the corresponding pixel signal values, and coordinate data of all the adjacent defective pixels may be determined and extracted and formed into one block based on the extracted defective pixel signals, which indicates positional information (local defective-pixel information). According to the run-length coding technique, however, the amount of positional information of defective pixels is smaller than that of the above-described technique. Thus, run-length coding is more advantageous in terms of reducing the storage area.

However, a different coding technique may be employed to reduce the storage area instead of the run-length coding technique.

Correction of defective pixel signals is discussed below with reference to Figs. 2 and 4.

Referring to Fig. 4, in step S5, the control unit 8 obtains the local defective-pixel information stored in the

data storage unit 6. Then, in step S6, the image processing unit 7 extracts an area which is required to be corrected from the subject-image signal based on the local defective-pixel information obtained in step S5. In step S7, the defective pixel signals within the extracted area are corrected. Finally, in step S8, the corrected image signal formed by the corrected defective pixel signals is embedded into the original subject-image signal by replacing the defective pixel signals. According to the above-described operation, corrections are repeatedly performed on all the items of local defective-pixel information.

The operations of steps S6 and S7 are described below in detail with reference to Figs. 8 and 9.

In step S6, a local defective-pixel block corresponding to the local defective-pixel information stored in the data storage unit 6 is extracted, as shown in Fig. 8, from an image signal obtained by taking an image of a subject. The local defective-pixel block includes defective pixels and pixels required for correcting the defective pixel signals. The local defective-pixel information may include positional information concerning only defective pixel signals or include positional information concerning both defective pixels and pixels required for correcting the defective pixel signals. If the local defective-pixel information includes only positional information of the defective pixels,

an area which is required to be corrected must be calculated by the control unit 8 based on the defective-pixel positional information. If, however, the positional information of the above-described area is also included in the local defective-pixel information, the time for calculations can be reduced, thereby enabling a faster operation.

In step S7, a defective pixel signal is corrected, as shown in Fig. 9, by an average of the pixel signals of the surrounding eight pixels. In this case, among the surrounding eight pixels, defective pixel signals cannot be utilized. In this embodiment, however, any defective pixel signals of defective pixels near a given defective pixel are extracted together with the defective pixel signal of the given defective pixel and are formed into a single block. It is thus possible to determine which pixel signals cannot be utilized for corrections. The corrected pixel signals (local corrected pixel signals) are then embedded into the original image in place of the defective pixel signals.

Although in the foregoing embodiment a given defective pixel signal is corrected by the average pixel signal of the surrounding eight pixels, the average pixel signal of the surrounding four pixels in the vertical and horizontal directions may be used. In this case, defective pixels obliquely adjacent to the given defective pixel in the

sensor may not be necessarily formed into the same group as the given pixel, and it is essential only that defective pixels vertically or horizontally adjacent to the given defective pixel in the sensor may be formed into the same group as the given defective pixel.

The number of pixels used for corrections may be increased, in which case, the weighted mean of an increased number of pixels may be used.

In using a sensor with color filters, such as the one shown in Fig. 10, a defective pixel signal of a given defective pixel of a blue (B) or red (R) color cannot be corrected by using pixel signals of adjacent pixels. Accordingly, as illustrated in Fig. 10, if a defective pixel is contained in the surrounding B-color eight pixels around a B-color pixel which is to have its defective pixel signal corrected, it is required to be formed into one group.

As discussed above, pixels can be formed into a suitable block range according to which pixel signals are to be used for correcting defective pixel signals. Positional information of the defective pixel signals by blocks is stored in the data storage unit 6, and is extracted by blocks, thereby achieving fast correction of defective pixel signals. It is also possible to determine which pixels in the sensor are defective pixels.

In the above-described embodiment, defective pixel

signals are extracted and are formed into a block, and are then corrected in the image processing unit within a single image processing apparatus. However, different image processing apparatuses may be employed. That is, defective pixel signals may be extracted and formed into a block in one image processing apparatus, and may then be corrected in another image processing apparatus.

Fig. 11 illustrates the entire configuration of a digital X-ray system using the image processing apparatus of the foregoing embodiment.

In Fig. 11, the digital X-ray system includes an X-ray sensor 1 for receiving X rays, a subject (for example, a patient) 2, an X-ray generating device (X-ray source) 3, an X-ray-generating-device control unit 4, the image processing apparatus 20 of the above-described embodiment for performing predetermined image processing in response to a signal from the X-ray sensor 1, a diagnosis monitor 9 for monitoring an image processed in the image processing apparatus 20, an operation unit 10 for performing a predetermined operation on the image processing apparatus 20, a network 11, which is a transmission medium for transmitting the image data processed by the image processing apparatus 20, a printer 12 for outputting the image data, a diagnosis workstation 13 installed with a diagnosis monitor for monitoring image data, and an image

database 14 for storing image data.

A storage medium for storing software program code which implements the functions of the above-described embodiment may be supplied to a system or a device. Then, a computer (or CPU or an MPU) of the system or the device may read the program code stored in the storage medium and execute it, so that the above-described functions can be implemented.

In this case, program code itself implements the functions of the foregoing embodiment, and a storage medium for storing the program code constitutes the present invention.

Examples of the storage medium for storing the program code include a floppy disk, a hard disk, an optical disc, a magneto-optical disk, a CD-ROM, a CD-R, a magnetic tape, a non-volatile memory card, and a ROM.

The function of the foregoing embodiment can be implemented not only by running the program code read by the computer, but also by partially or wholly executing the processing by, for example, an operating system (OS) or another application software program running in the computer according to instructions of the program code.

The present invention may also be implemented by the following modification. The program code may be read from the storage medium into a memory provided in a feature

expansion board inserted into a computer or a feature expansion unit connected to the computer. Then, a CPU provided in the feature expansion board or the feature expansion unit may partially or wholly execute the processing based on the instructions of the program code, thereby implementing the above-described functions.

As is seen from the foregoing description, the present invention offers the following advantages. Fast and precise correction of defective pixel signals can be achieved. Additionally, a storage area required for defective pixel information can be reduced by utilizing, for example, run-length coding.

While the present invention has been described with reference to what are presently considered to be the preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments. On the contrary, the invention is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

WHAT IS CLAIMED IS:

1. An image processing apparatus comprising:

extraction means for extracting a pixel signal of a defective pixel included in image pickup means having a plurality of pixels and determining a defective pixel; and

block-forming means for forming positional information of a plurality of the defective pixels determined by said extraction means into a block.

2. An image processing apparatus according to claim 1, further comprising storage means for storing the positional information of the defective pixels of the image pickup means in units of blocks formed by said block-forming means.

3. An image processing apparatus according to claim 1, wherein said block-forming means forms the positional information of the plurality of defective pixels of the image pickup means into the block by coding the positional information of the defective pixels.

4. An image processing apparatus according to claim 1, wherein said block-forming means forms the positional information of the plurality of defective pixels of the image pickup means into the block by using run-length coding.

5. An image processing apparatus according to claim 1, wherein the block comprises positional information of pixels in the image pickup means required for correcting the defective pixel signals.

6. An image processing apparatus according to claim 2, further comprising correction means for correcting the defective pixel signals in units of blocks included in said image-pickup means by using the positional information of the defective pixel signals stored in said storage means.

7. An image processing apparatus comprising:

storage means for storing, in units of blocks, positional information of a plurality of defective pixels included in image pickup means having a plurality of pixels; and

correction means for correcting defective pixel signals of the defective pixels in the image pickup means in units of blocks by using the positional information of the defective pixels stored in said storage means.

8. An image processing apparatus according to claim 7, wherein said storage means stores the positional information of the defective pixels in the image pickup means in units

of blocks by coding the positional information of the defective pixels in the image pickup means.

9. An image processing apparatus according to claim 7, wherein said storage means stores the positional information of the defective pixels in the image pickup means which are formed into the block by using run-length coding.

10. An image processing apparatus according to claim 7, wherein the block comprises positional information of pixels required for correcting defective pixel signals of the defective pixels in the image pickup means.

11. An image processing method comprising:

a first step of extracting a defective pixel signal of a defective pixel included in image pickup means having a plurality of pixels; and

a second step of forming positional information of a plurality of defective pixels included in the image pickup means into a block based on the extracted defective pixel signals.

12. An image processing method according to claim 11, wherein said second step forms the positional information of the defective pixels into the block by coding the positional

information of the defective pixels.

13. An image processing method according to claim 11, wherein said second step forms the positional information of the defective pixels into the block by using run-length coding.

14. An image processing method according to claim 11, wherein the block comprises positional information of pixels having pixel signals required for correcting the defective pixel signals.

15. An image processing method according to claim 11, further comprising a third step of correcting, in units of blocks, the defective pixel signals of the defective pixels included in the image pickup means by using the positional information of the defective pixels in the image pickup means formed into the block.

16. An image processing method comprising:

a first step of reading, in units of blocks, positional information of a plurality of defective pixels included in image pickup means having a plurality of pixels; and

a second step of correcting defective pixel signals of the defective pixels included in the image pickup means in

units of blocks.

17. An image processing method according to claim 16, wherein the positional information of the defective pixels in the image pickup means comprises coded information.

18. An image processing method according to claim 16, wherein the positional information of the defective pixels in the image pickup means comprises information using run-length coding.

19. An image processing method according to claim 16, wherein the block comprises positional information of pixels having pixel signals required for correcting the defective pixel signals.

20. A storage medium for storing a program which comprises:

a first step of extracting a defective pixel signal of a defective pixel included in image pickup means having a plurality of pixels; and

a second step of forming positional information of a plurality of defective pixels included in the image pickup means into a block based on the extracted defective pixel signals.

21. A storage medium according to claim 20, wherein said second step forms the positional information of the defective pixels into the block by coding the positional information of the defective pixels.

22. A storage medium according to claim 20, wherein said second step forms the positional information of the defective pixels into the block by using run-length coding.

23. A storage medium according to claim 20, wherein said program further comprises a third step of including positional information of pixels having pixel signals required for correcting the defective pixel signals in the block.

24. A storage medium according to claim 20, wherein said program comprises a fourth step of correcting, in units of blocks, the defective pixel signals of the defective pixels included in the image pickup means by using the positional information of the defective pixels in the image pickup means formed into the block.

25. A storage medium for storing a program which comprises:

a first step of reading, in units of blocks, positional information of a plurality of defective pixels included in image pickup means having a plurality of pixels; and

a second step of correcting defective pixel signals of the defective pixels included in the image pickup means in units of blocks.

26. A recording medium according to claim 25, wherein said first step forms the positional information of the defective pixels in the image pickup means into the block by coding the positional information of the defective pixels in the image pickup means.

27. A storage medium according to claim 25, wherein said program further comprises a third step of forming the positional information of the defective pixels in the image pickup means into the block by using run-length coding.

28. A storage medium according to claim 25, wherein said program further comprises a fourth step of including positional information of pixels having pixel signals required for correcting the defective pixel signals in the block.

29. An image processing system comprising:

image pickup means having a plurality of pixels for picking up an image of a subject;

an image processing apparatus for performing image processing of an image signal from said image pickup means, comprising:

storage means for storing, in units of blocks, positional information of a plurality of defective pixels included in said image pickup means having a plurality of pixels; and

correction means for correcting defective pixel signals of the defective pixels in the image pickup means in units of blocks by using the positional information of the defective pixels stored in said storage means;

a monitor for monitoring the image signal processed by said image processing apparatus;

a network for transmitting the image signal processed by said image processing apparatus; and

an image database, connected to said network, for storing the image signal.

ABSTRACT OF THE DISCLOSURE

An image processing system which processes an image signal, and determines, extracts and corrects defective pixel signals from defective pixels in a sensor array including a plurality of pixels. A given pixel signal from a pixel in the array is determined to be defective if it has a signal level below a threshold value, as determined by an extraction unit which then extracts each defective pixel signal from the defective pixels in the array. A block-forming unit forms positional information for each defective pixel having a defective pixel signal extracted by the extraction unit, with positional information for a group of such extracted defective pixel signals being formed into a block. A storage units stores, in units of blocks, positional information for the defective pixel signals. A correction unit corrects the defective pixel signals by using the positional information, in units of blocks, stored in the storage unit. The defective pixel signals in the image signal are then replaced by corresponding corrected defective pixel signals.

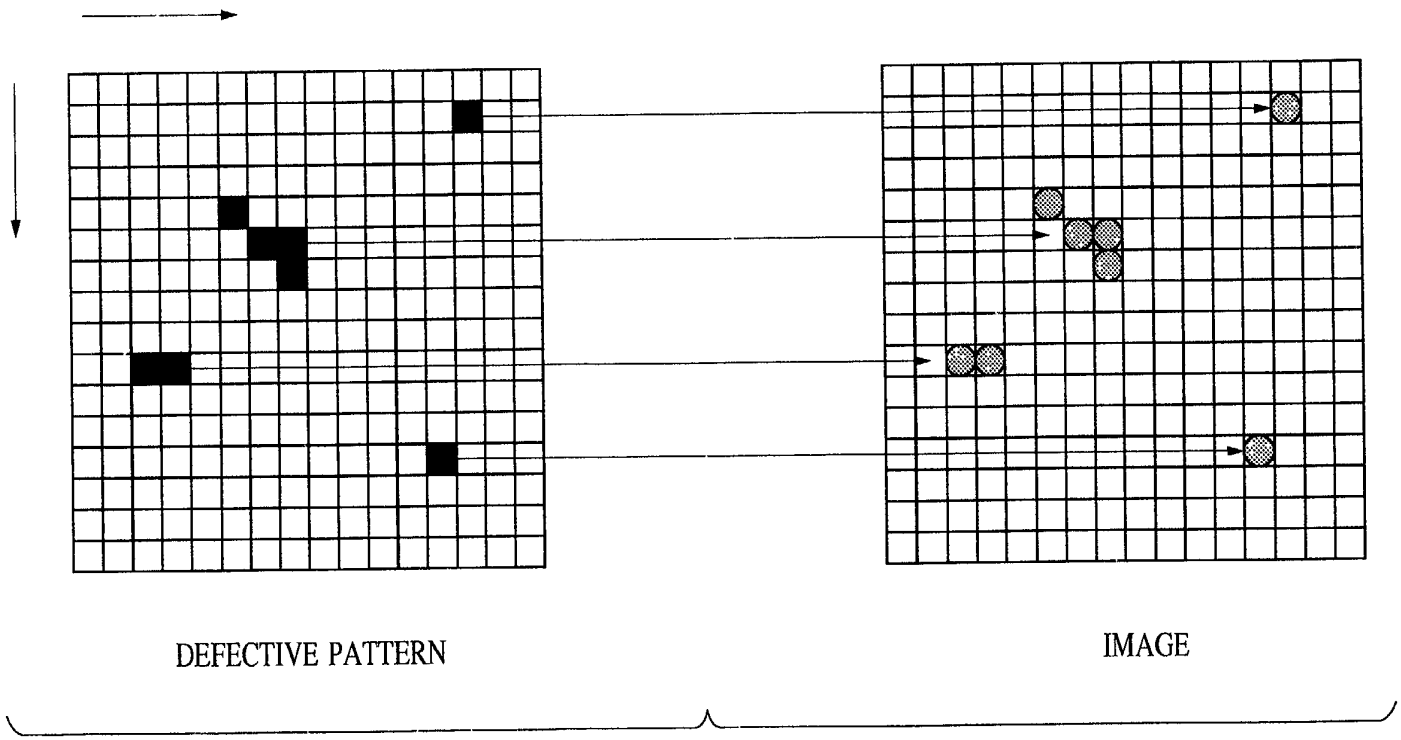


FIG. 1

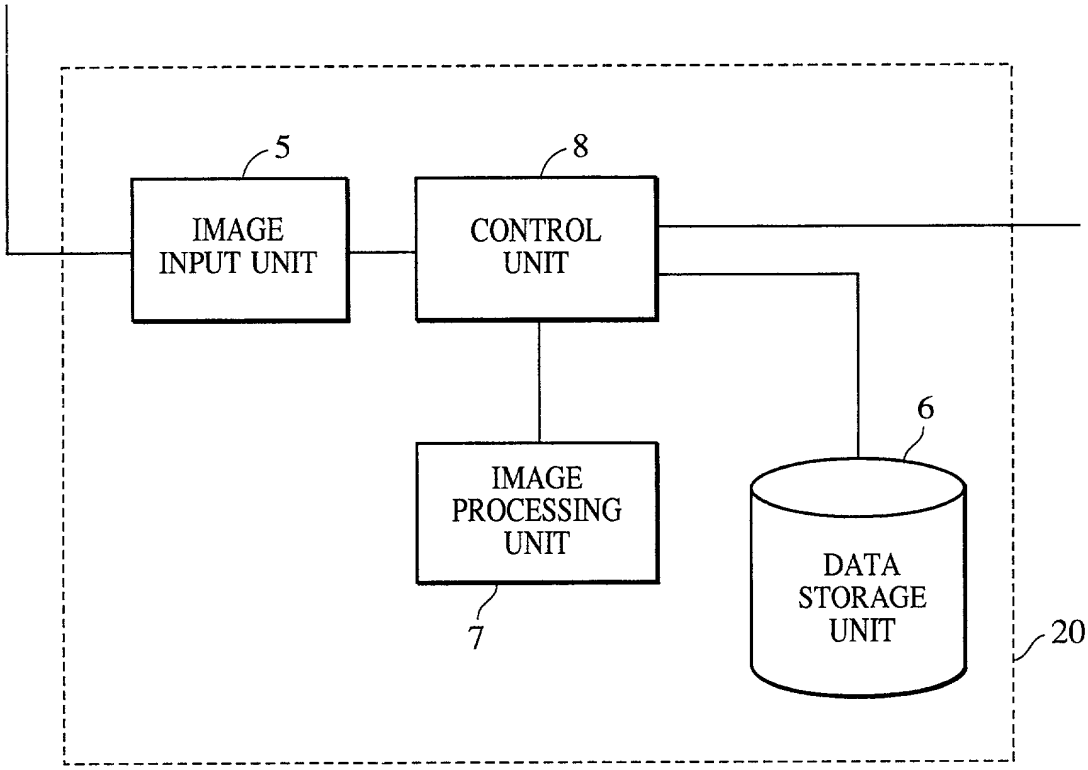

5
8
IMAGE
INPUT UNIT
CONTROL
UNIT
6
IMAGE
PROCESSING
UNIT
DATA
STORAGE
UNIT
7
20

FIG. 2

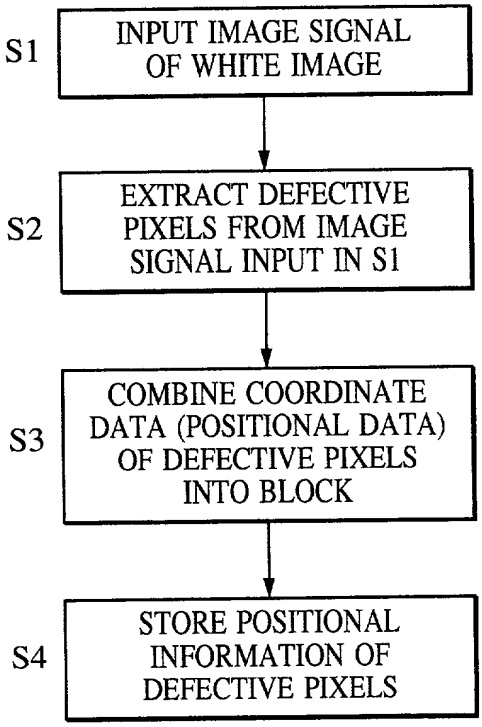

S1
INPUT IMAGE SIGNAL OF WHITE IMAGE
S2
EXTRACT DEFECTIVE PIXELS FROM IMAGE SIGNAL INPUT IN S1
S3
COMBINE COORDINATE DATA (POSITIONAL DATA) OF DEFECTIVE PIXELS INTO BLOCK
S4
STORE POSITIONAL INFORMATION OF DEFECTIVE PIXELS

FIG. 3

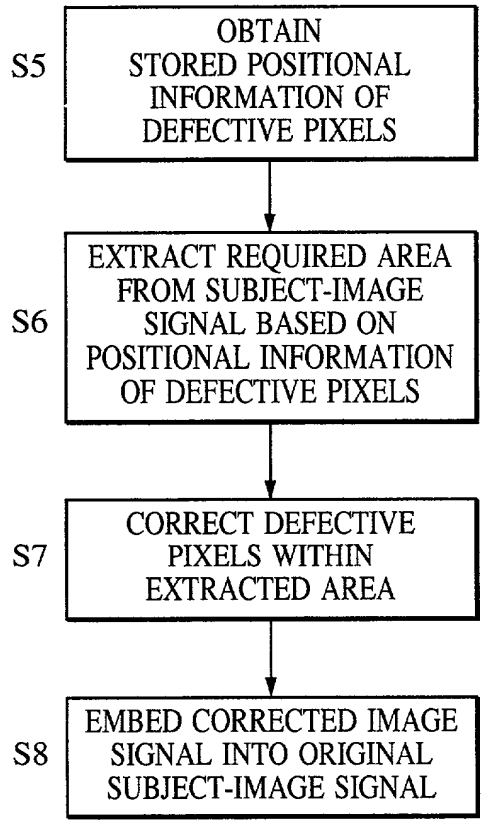

S5
OBTAIN STORED POSITIONAL INFORMATION OF DEFECTIVE PIXELS
S6
EXTRACT REQUIRED AREA FROM SUBJECT-IMAGE SIGNAL BASED ON POSITIONAL INFORMATION OF DEFECTIVE PIXELS
S7
CORRECT DEFECTIVE PIXELS WITHIN EXTRACTED AREA
S8
EMBED CORRECTED IMAGE SIGNAL INTO ORIGINAL SUBJECT-IMAGE SIGNAL

FIG. 4

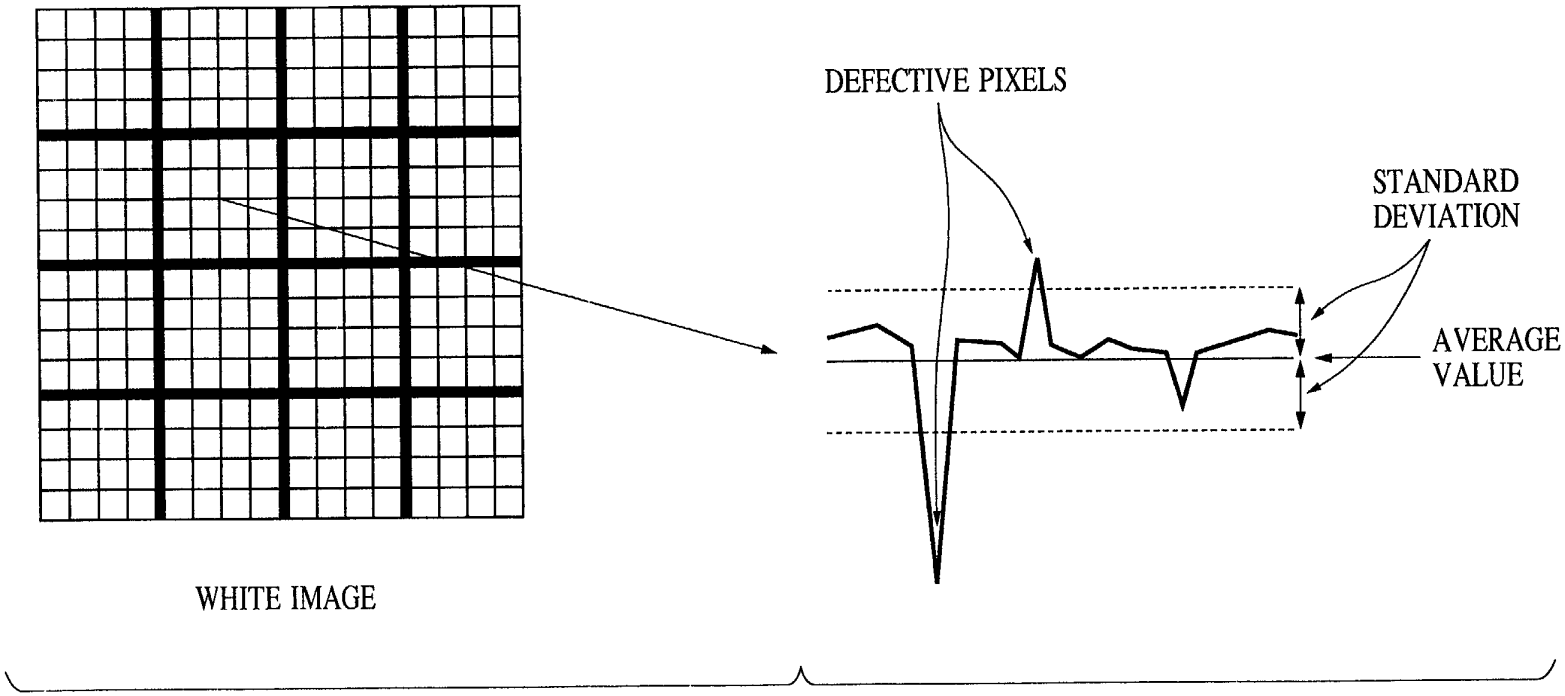

DEFECTIVE PIXELS
STANDARD DEVIATION
AVERAGE VALUE
WHITE IMAGE

FIG. 5

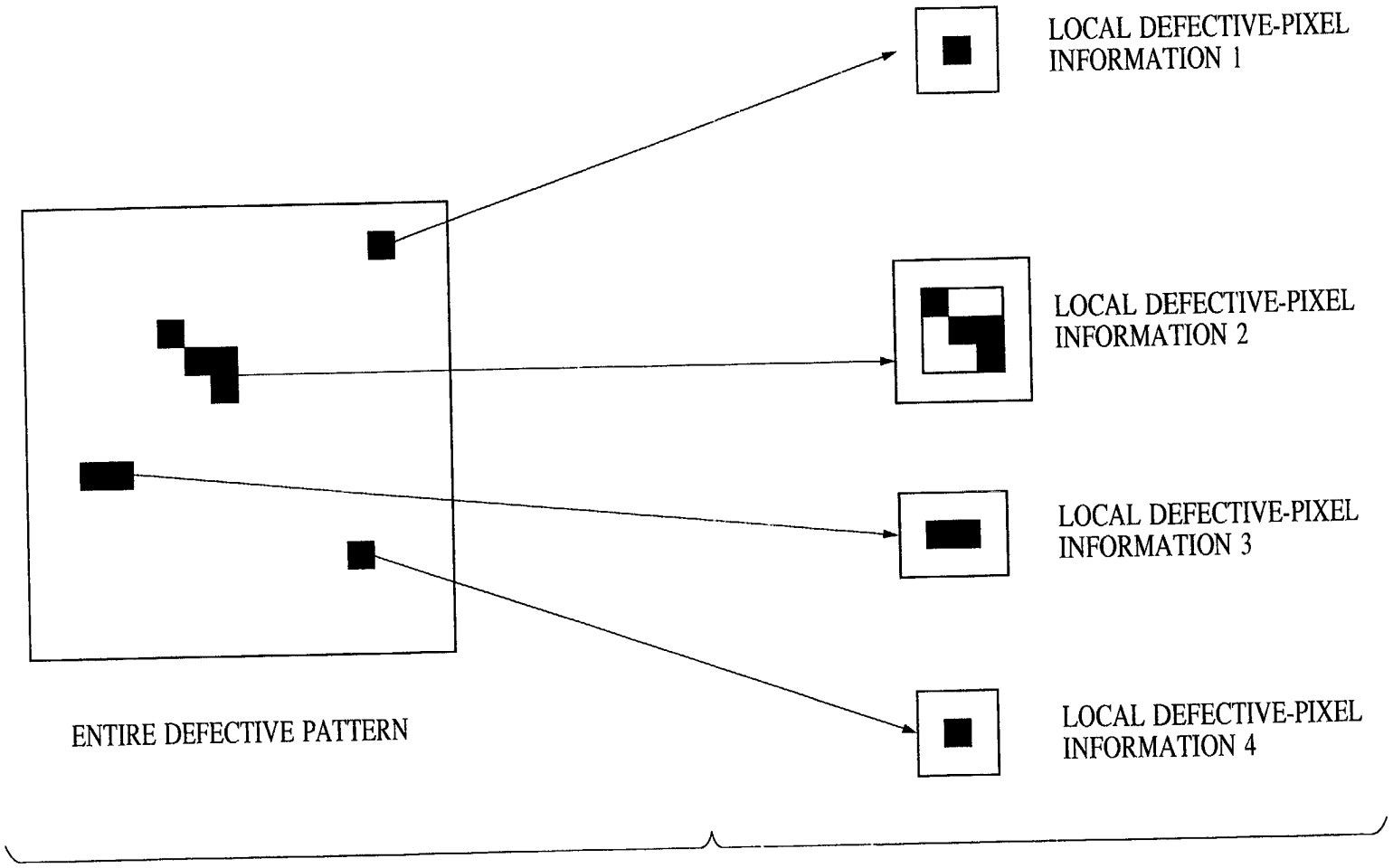
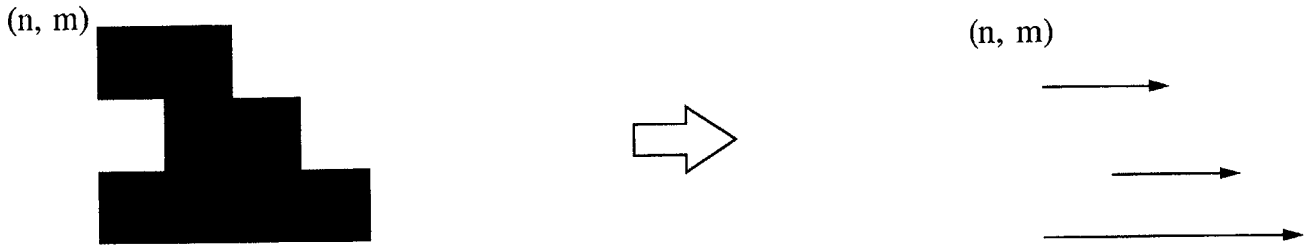


FIG. 6



POSITIONAL INFORMATION OF DEFECTIVE PIXELS

(n, m)
(n+1, m)
(n+1, m+1)
(n+2, m+1)
(n, m+2)
(n+1, m+2)
(n+2, m+2)
(n+3, m+2)

POSITIONAL INFORMATION OF DEFECTIVE PIXELS REPRESENTED BY RUN-LENGTH CODE

(n, m) L2
(n+1, m+1) L2
(n, m+2) L4

FIG. 7

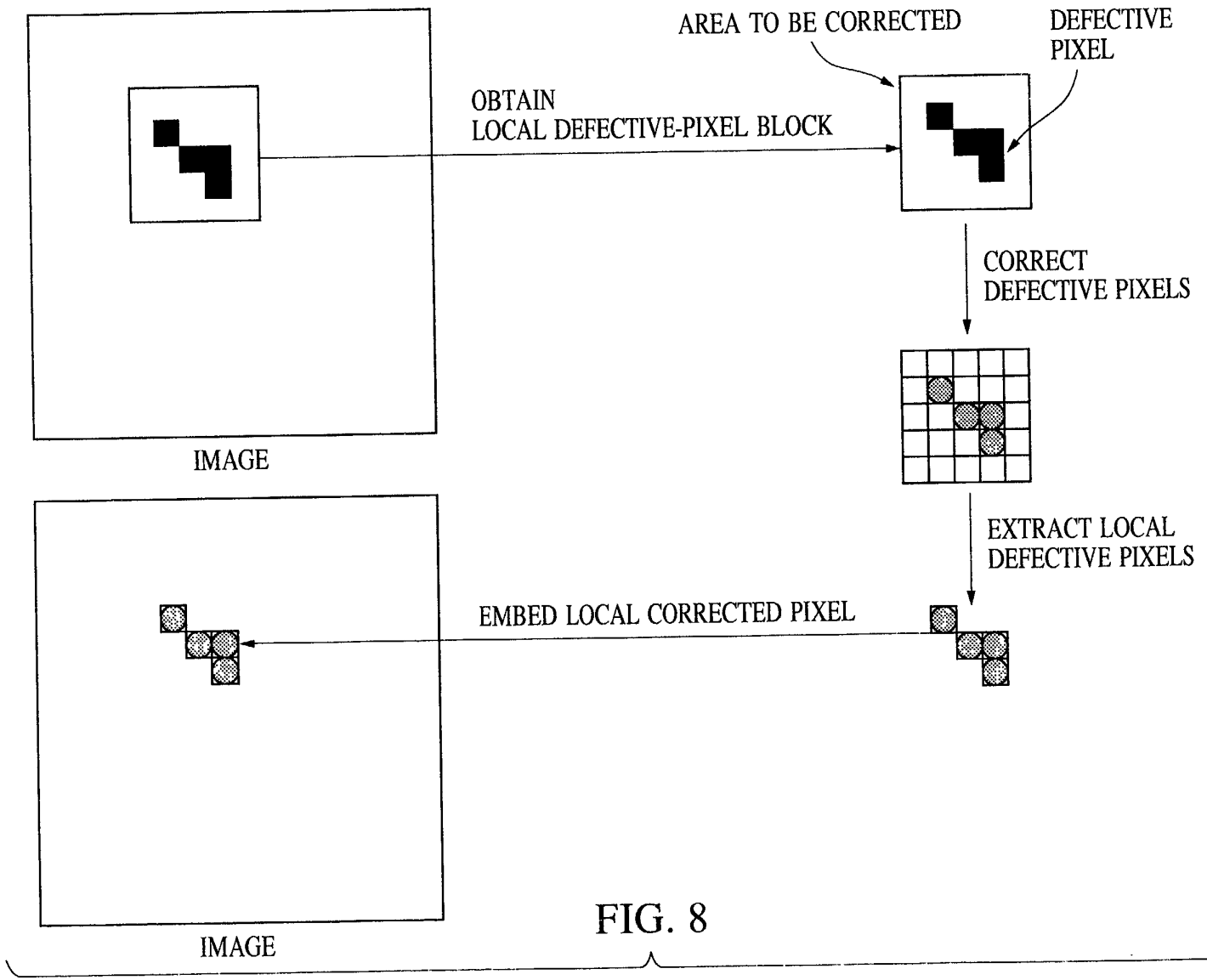

AREA TO BE CORRECTED
DEFECTIVE PIXEL
OBTAIN
LOCAL DEFECTIVE-PIXEL BLOCK
CORRECT
DEFECTIVE PIXELS
EXTRACT LOCAL
DEFECTIVE PIXELS
EMBED LOCAL CORRECTED PIXEL
IMAGE
IMAGE

FIG. 8

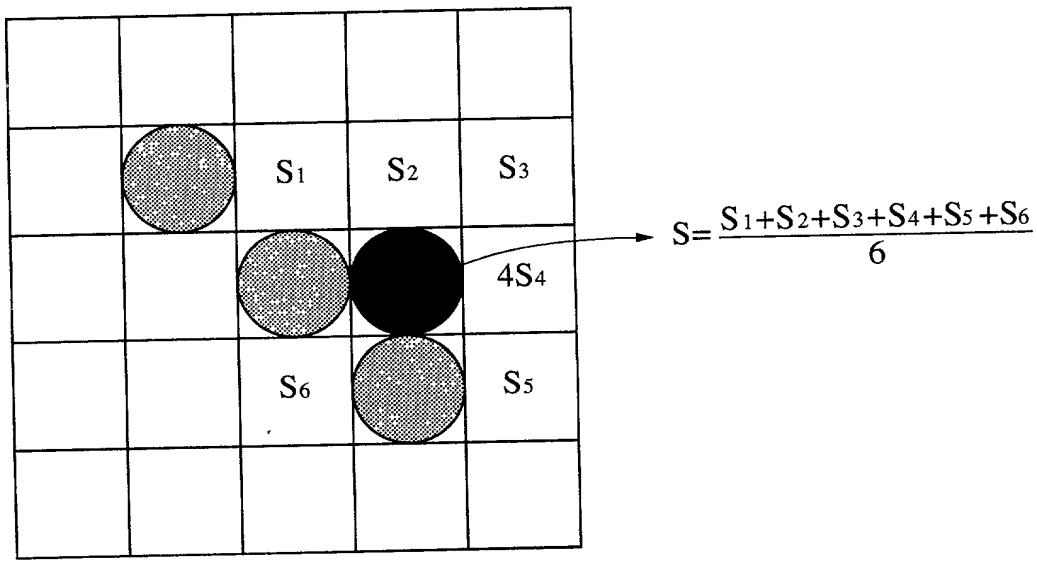


FIG. 9

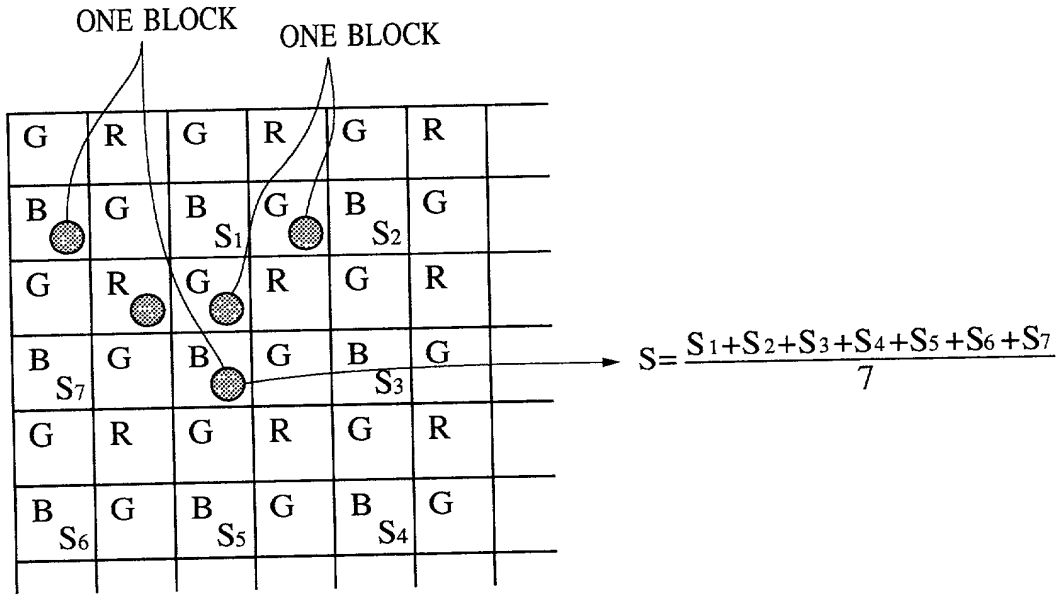

ONE BLOCK
ONE BLOCK
G R G R G R
B G B G B G
S1 S2
G R G R G R
B G B G B G
S7 S3
G R G R G R
B G B G B G
S6 S5 S4
S= S1+S2+S3+S4+S5+S6+S7 / 7

FIG. 10

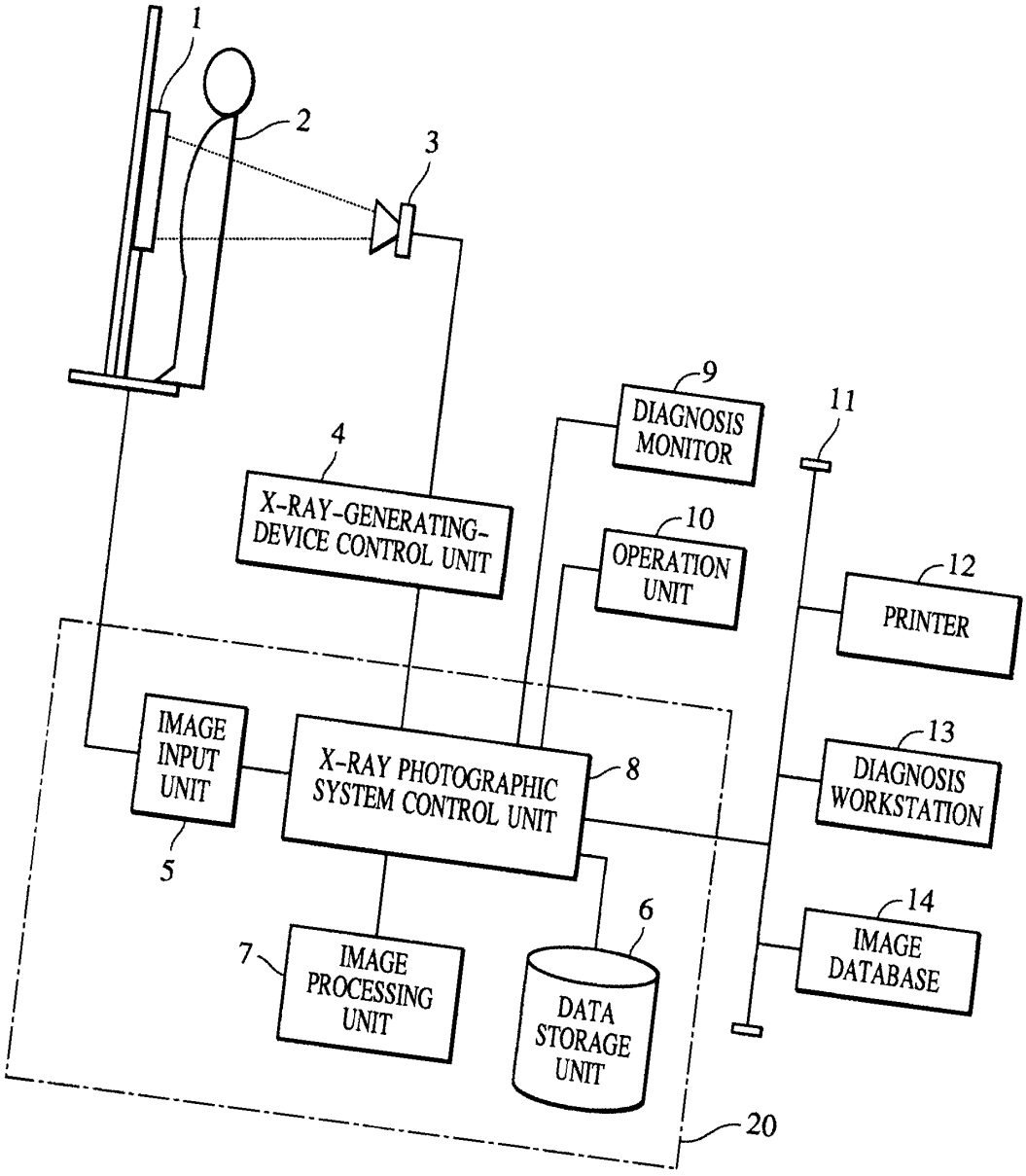

1
2
3
4
X-RAY-GENERATING-DEVICE CONTROL UNIT
9
DIAGNOSIS MONITOR
10
OPERATION UNIT
11
12
PRINTER
IMAGE INPUT UNIT
5
X-RAY PHOTOGRAPHIC SYSTEM CONTROL UNIT
8
13
DIAGNOSIS WORKSTATION
7
IMAGE PROCESSING UNIT
6
DATA STORAGE UNIT
14
IMAGE DATABASE
20

FIG. 11

COMBINED DECLARATION AND POWER OF ATTORNEY
FOR PATENT APPLICATION
(Page 1)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled IMAGE PROCESSING APPARATUS

the specification of which [X] is attached hereto [ ] was filed on _____ as United States Application No. or PCT International Application No. _____ and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR §1.56

I hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) or §365(b), of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT international application which designates at least one country other than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate, or PCT international application having a filing date before that of the application on which priority is claimed:

Country	Application No.	Filed (Day/Mo./Yr.) (Yes/No)	Priority Claimed
Japan	101205/1999	08/04/99	Yes

I hereby claim the benefit under 35 U S C. § 120 of any United States application(s), or § 365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 C.F.R. § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

Application No.	Filed (Day/Mo./Yr.)	Status (Patented, Pending, Abandoned)

I hereby appoint the practitioners associated with the firm and Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and direct that all correspondence be addressed to the address associated with that Customer Number:

FITZPATRICK, CELLA, HARPER & SCINTO
Customer Number: 05514

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole or First Inventor HIROYUKI URUSHIYA

Inventor's signature _____

Date _____ Citizen/Subject of Japan

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